rorm Approvea REPORT DOCUMENTATION PAGE OMB No. 0704-0188 Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS. 1. REPORT DATE (DD-MM-YYYY) 2. REPORT TYPE 3. DATES COVERED (From - To) **Technical Papers** 4. TITLE AND SUBTITLE 5a. CONTRACT NUMBER **5b. GRANT NUMBER** 5c. PROGRAM ELEMENT NUMBER 6. AUTHOR(S) **5d. PROJECT NUMBER 5e. TASK NUMBER** 5f. WORK UNIT NUMBER 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) 8. PERFORMING ORGANIZATION REPORT Air Force Research Laboratory (AFMC) AFRL/PRS 5 Pollux Drive Edwards AFB CA 93524-7048 9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) 10. SPONSOR/MONITOR'S ACRONYM(S) Air Force Research Laboratory (AFMC) AFRL/PRS 11. SPONSOR/MONITOR'S 5 Pollux Drive NUMBER(S) Edwards AFB CA 93524-7048 12. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution unlimited. 13. SUPPLEMENTARY NOTES 14. ABSTRACT

20021018 068

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON Leilani Richardson
a. REPORT	b. ABSTRACT	c. THIS PAGE	A		19b. TELEPHONE NUMBER (include area code)
Unclassified	Unclassified	Unclassified			(661) 275-5015

9 items enclosed

15. SUBJECT TERMS

29

MEMORANDUM FOR PRS (In-House/Contractor Publication)

FROM: PROI (STINFO)

14 May 2002

SUBJECT: Authorization for Release of Technical Information, Control Number: AFRL-PR-ED-AB-2002-111
Frank Gulczinski (PRSS) and John Schilling (W.E.), "Comparison of Orbit Transfer Vehicle Concepts Utilizing Mid-Term Power and Propulsion Options"

28th International Electric Propulsion Conference (Toulouse, France, 17-21 March 2003) (Deadline: 14 June 2002)

(Statement A)

1. This request has been reviewed by the Foreign Disclosure C b.) military/national critical technology, c.) export controls or d.) appropriateness for release to a foreign nation, and e.) technology.	distribution restrictions, nical sensitivity and/or economic sensitivity.
Signature	Date
2. This request has been reviewed by the Public Affairs Office and/or b) possible higher headquarters review. Comments:	•
Signature	Date
3. This request has been reviewed by the STINFO for: a.) charbon appropriateness of references, if applicable; and c.) format a Comments:	and completion of meeting clearance form if required
Signature	Date
4. This request has been reviewed by PR for: a.) technical accumpropriateness of distribution statement, d.) technical sensitive national critical technology, and f.) data rights and patentability Comments:	vity and economic sensitivity, e.) military/

APPROVED/APPROVED AS AMENDED/DISAPPROVED

PHILIP A. KESSEL Date
Technical Advisor
Space and Missile Propulsion Division

16 Jul 22

Comparison of Orbit Transfer Vehicle Concepts Utilizing Mid-Term Power and Propulsion Options

Frank S. Gulczinski III
AFRL Propulsion Directorate (AFRL/PRSS)

1 Ara Road
Edwards AFB, CA 93524-7013
frank.gulczinski@edwards.af.mil

John H. Schilling
W.E. Research
4360 San Juan Ct.
Rosamond, CA 93560
schilling@spock.usc.edu

ABSTRACT

The recent announcement of a national nuclear space flight initiative has rekindled interest in nuclear propulsion options within the spacecraft propulsion community. Therefore, the Air Force Research Laboratory Propulsion Directorate (AFRL/PRSS) has decided to reexamine the value of utilizing nuclear propulsion for orbit transit and the repositioning of future Air Force space assets. A trade study was conducted with the assumption that technologies had matured to the 2010 level. A comparison was made between advanced chemical, solar thermal, solar electric, and nuclear electric for both expendable and reusable mission concepts, with a particular interest in options that resulted in trip times of 30 days or less. Results show that for expendable stages both solar thermal and, to a greater degree, solar electric propulsion systems can provide a significant increase in payload delivered from LEO to GEO within the required trip times. The solar electric concepts utilize clustered Hall thrusters, thin film photovoltaic solar arrays for power generation, and advanced power processing topologies for power conversion. The nuclear electric option became advantageous for trip times greater than 30 days. For reusable vehicles, where payload and fuel are supplied to a reusable propulsion tug module, similar results were calculated based on trip time. However, with a reusable stage, other considerations related to component degradation in the space environment must be considered. This consideration results in a rapid degradation of the thin film arrays used for solar electric stages due to Van Allen belt radiation, whereas the reactors utilized for the nuclear electric options are hardened to prevent radiation damage to payload and thus are protected from the natural space environment. Thus, for a reusable orbit transfer vehicle, a nuclear electric tug becomes an attractive option for repositioning and transiting Air Force space assets.

¹ David, L., "NASA To Go Nuclear; Spaceflight Initiative Approved," Space.com, www.space.com/news/nasa_nuclear_020205.html, February 5, 2002.